Chapter 5
Prepare the Site

This chapter describes how to prepare your site so that you can install a T320 Internet router, discussing the following topics:

Mounting Requirements on page 45

Clearance Requirements on page 47

Environmental Requirements on page 48

Fire Safety Requirements on page 48

Power Requirements and Specifications on page 49

System Grounding Guidelines on page 53

Network Cable Requirements on page 53

Site Wiring Guidelines on page 54

Fiber-Optic Connection Guidelines on page 55

Site Preparation Checklist on page 60

Mounting Requirements

The router must be mounted in a rack. It can be mounted in several types of racks, including the following:

- Standard (EIA or IEC) 19-in. equipment rack, 44-U tall
- Telco four-post rack
- Center-mount rack
- Front-mount rack

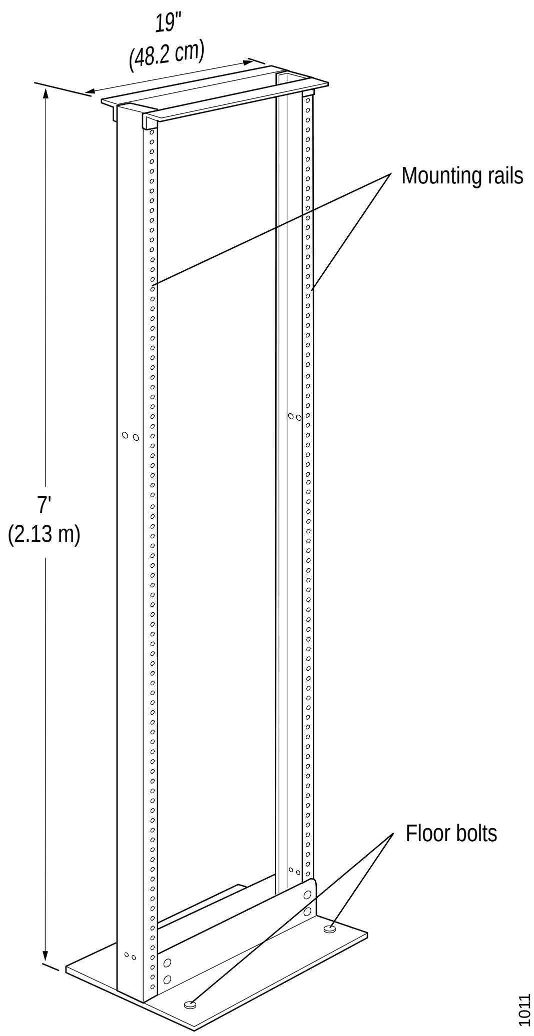
You must select a rack that meets the following requirements:

Alignment of Rack-Mounting Holes on page 46

Rack Size and Strength on page 47

Rack Security on page 47

Figure 24: Typical Center-Mount Rack



Alignment of Rack-Mounting Holes

The mounting holes on the rack rails must align with the mounting holes on the chassis mounting ears. The chassis is equipped with two sets of rack-mounting ears, one set intended for front-mount and four-post racks and cabinets and another set intended for center-mount racks. The mounting holes on both sets of rack-mounting ears are spaced at 5.25 in. (13.35 cm).

Rack Size and Strength

The rack must be large enough to accommodate the router chassis, which is 25.13 in. (63.82 cm) high, 17.4 in. (44.2 cm) wide, and 31 in. (78.7 cm) deep. It must also be strong enough to support the weight of a fully configured router, up to about 369.9 lb (167.8 kg). If you mount three routers in one rack, it must be capable of supporting the routers' combined weight, which can be greater than 1100 lb (499 kg).

Rack Security

When planning rack space for the router, follow these guidelines for securing the racks:

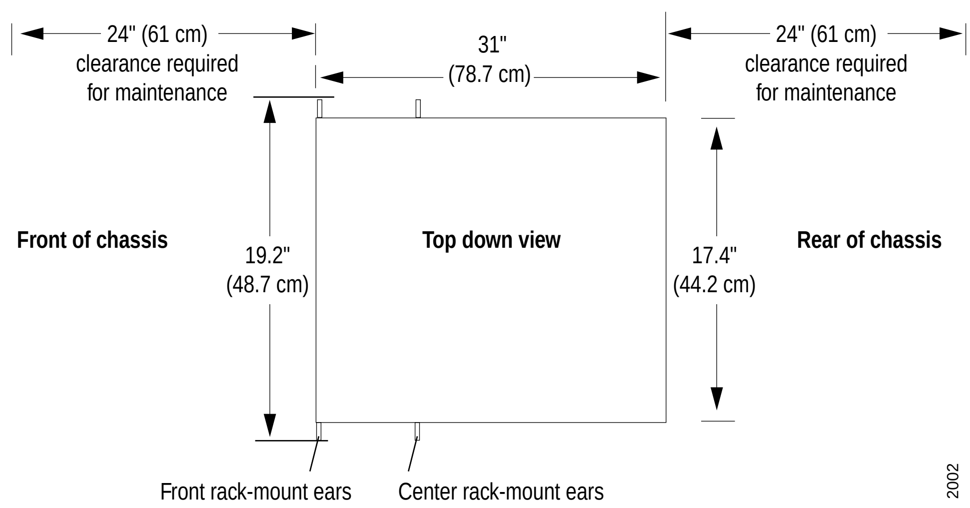
- Secure the rack to the structure of the building.
- If your geographical area is subject to earthquakes, bolt the rack to the floor.
- To maximally stabilize the system, secure the rack to ceiling brackets.

For information regarding rack-mounting requirements and safety, see "Rack-Mounting Requirements and Warnings" on page 84.

Clearance Requirements

When planning the installation site, you need to allow sufficient clearance around the rack for maintenance access to the router, at least 24 in. (61 cm) in front of and behind the rack. In the front, you must allow adequate space to remove and install FPCs, PICs, and fan trays. In the rear, you must allow adequate space to remove and install the SIBs, Routing Engines, power supplies, and other components.

Figure 25: Chassis Dimensions and Clearance Requirements



Air Flow

The cooling system must have unrestricted airflow to function properly. Allow at least 6 in. (15.2 cm) on each side of the rack for airflow.

Environmental Requirements

Table 17 lists the site environmental specifications of the router. Make sure your installation site is within the listed specifications.

Make sure that the air circulating through the router is as dust-free as possible. Dust can clog the air filters, causing the cooling system to operate less efficiently. You should frequently check the front and rear air filters and clean them if necessary. For more information, see “Maintain and Replace Cooling System Components” on page 143.

Table 17: Environmental Requirements

Category	Specification
Altitude	No performance degradation to 10,000 ft (3048 m)
Relative humidity	Normal operation ensured in relative humidity range of 5% to 90%, noncondensing
Temperature	Normal operation ensured in temperature range of 32^{o}F (0^{o}C) to 104^{o}F (40^{o}C)
Shock	Tested to meet Bellcore Zone 4 earthquake requirements
Thermal output	10,000 BTU/hour (3200 W)

Fire Safety Requirements

In the event of a fire emergency involving routers and other network equipment, the safety of people is the primary concern. You should establish procedures for protecting people in the event of a fire emergency, provide safety training, and properly provision fire-control equipment and fire extinguishers.

In addition, you should establish procedures to protect your equipment in the event of a fire emergency. Juniper Networks products should be installed in an environment suitable for electronic equipment. We recommend that fire suppression equipment be available in the vicinity of the equipment, and that all local fire, safety, and electrical codes and ordinances be observed when installing and operating your equipment.

Fire Suppression

In the event of an electrical hazard or an electrical fire, you should first turn power off to the equipment at the source. Then, use a Type C fire extinguisher, which uses noncorrosive fire retardants, to extinguish the fire. For more information about fire extinguishers, see “Fire Suppression Equipment” on page 49.

Fire Suppression Equipment

Type C fire extinguishers, which use noncorrosive fire retardants such as carbon dioxide (CO_2) and Halotron, are most effective for suppressing electrical fires. Type C fire extinguishers displace the oxygen from the point of combustion to eliminate the fire. For extinguishing fire on or around equipment that draws air from the environment for cooling, you should use this type of inert oxygen displacement extinguisher instead of an extinguisher that leaves residue on equipment.

Do not use multipurpose Type ABC chemical fire extinguishers (dry chemical fire extinguishers) near Juniper Networks equipment. The primary ingredient in these fire extinguishers is monoammonium phosphate, which is very sticky and difficult to clean. In addition, in minute amounts of moisture, monoammonium phosphate can become highly corrosive to most metals.

Any equipment in a room in which a chemical fire extinguisher has been discharged is subject to premature failure and unreliable operation. The equipment is considered to be irreparably damaged. We recommend that you dispose of any irreparably damaged equipment in an environmentally responsible manner.

Note

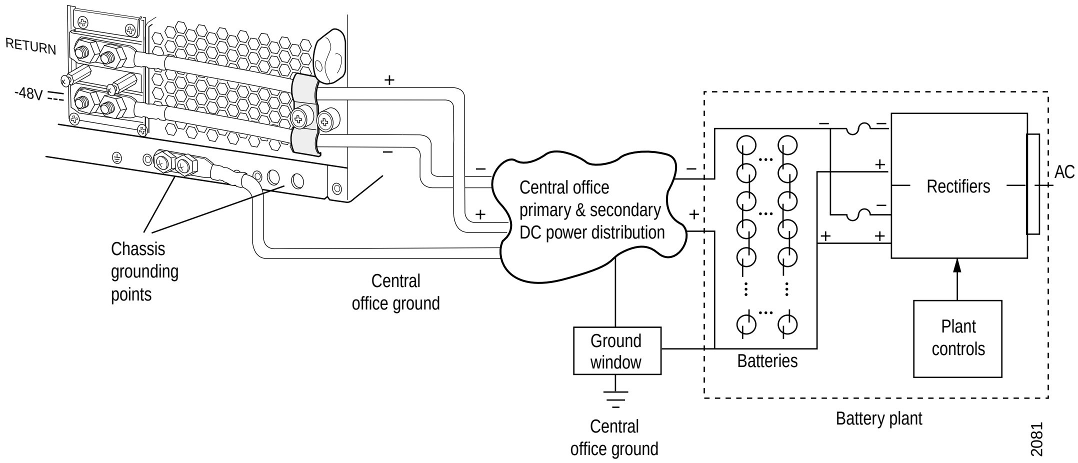
If a dry chemical fire extinguisher is used to control a fire at or near a Juniper Networks router, any warranty in effect is void. The unit is no longer eligible for coverage under a service agreement.

Power Requirements and Specifications

The router is equipped with two redundant, load-sharing DC power supplies. Each power supply has one input, which has its own circuit breaker, and requires a dedicated DC power source.

DC power is normally carried around the site through a main conduit to frame-mounted DC power distribution panels, one of which might be located at the top of the rack where the router is to be installed. One pair of cables connects each DC supply to the power distribution panel. Grounding points are provided on the bottom rear of the router chassis (see Figure 26).

Figure 26: Typical DC Source Cabling to the Router



For electrical safety information, see “Electricity Safety Guidelines and Warnings” on page 64.

For more information about the power supplies, see “Power Supplies” on page 26.

This section describes the following:

- Power Supply Load Sharing and Redundancy on page 50
- Power and Grounding Cable Specifications on page 51
- System Power Requirements on page 51

Power Supply Load Sharing and Redundancy

The router operates with two redundant power supplies. When the router is operating normally and both power supplies are switched on, load-sharing between them occurs automatically. When one power supply fails or is turned off, the other power supply immediately assumes the entire electrical load for the system. A single power supply can provide full power for as long as the router is operational.

Power and Grounding Cable Specifications

The DC power cables attach to the leads on the power supply faceplate with cable lugs (see Figure 27). DC power cables should be 6 AWG (13.3 mm^2), 90 C (194 F) high-strand-count braided wire. The cables should be terminated in a Listed Double size hole lug suitable for connection to the terminal studs of the power supply. DC power cables are not provided with the router. Table 18 shows the specifications for power and grounding cables.

> **Caution**
>
> Before router installation begins, a licensed electrician must attach the cable lugs to the power cables that you supply. Cables with incorrectly attached lugs can damage the router (for example, by causing a short circuit in the circuit breaker box).

Figure 27: Power Cable Lugs

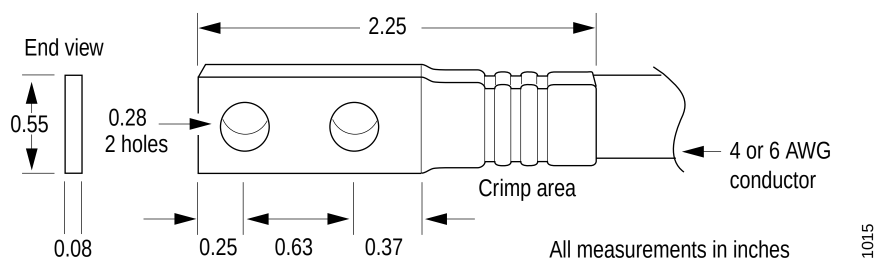


Table 18: Power and Grounding Cable Specifications

Cable Type	Cable Specification	Supplied	Maximum Length	Other Parts Required	Connector Specification
Power cables	6 AWG (13.3 mm2), 90°C (194°F) braided wire cables	No	None	Four washers and nuts	Cable lug; dual hole, sized to fit 1/4-20 UNC terminal studs at 15.86-mm (0.625-in.) center line.
Grounding cables	6 AWG (13.3 mm2), 90°C (194°F) braided wire cables	No	None	Two washers and bolts	Cable lug; dual hole. Left pair: sized to fit M6 grounding studs. Right pair: sized to fit 1/4-20 UNC grounding studs.

System Power Requirements

Table 19 lists the power requirements for the individual hardware components when the router is operating under typical voltage conditions.

For electrical specifications of the power supplies, see “Power Supply Electrical Specifications” on page 27.

Table 19: System Power Requirements

Component	Power (amps)
Base system (includes three SIBs, one host subsystem, one SCG, two power supplies, cooling system, and craft interface but does not include FPCs or PICs)	9 A/48 V
SIB-I8	0.8 A/48 V
FPC1	3.5 A/48 V
FPC2	3.5 A/48 V
FPC3	3.8 A/48 V
Host subsystem (Routing Engine and CB)	2.6 A/48 V
SCG	0.2 A/48 V
Power supply	0.8 A/48 V
Cooling system (normal speed)	1.7 A/48 V
Cooling system (full speed)	4.5 A/48 V
4-port Gigabit Ethernet PIC	0.4 A/48 V
SONET/SDH OC-48/STM-16 PIC (FPC3)	0.6 A/48 V
SONET/SDH OC-192/STM-64 PIC (FPC3)	0.5 A/48 V
Tunnel Services PIC (FPC3)	0.1 A/48 V

Power Consumption Examples

The following examples illustrate how you can use the information in Table 19 to calculate power consumption for various configurations, input current from a different source voltage, and thermal output.

Power consumption for minimum configuration:

Base System + 1 FPC3 + 2(OC-192) PICs
9A + 3.8A + 2(0.5A) =
9A + 3.8A + 1A =
13.8A @ 48V

Power consumption for maximum configuration:

Base System + 8 FPC3 + Host + SCG + 16(OC-192) PICs
9A + 8(3.8A) + 2.6A + 0.2A + 16(0.5A) =
9A + 30.4A + 2.6A + 0.2A + 8A =
50.2A @ 48V

Power consumption adjustment for fans running at full speed (high temperature environment or cooling component failure):

Calculated system current (x) – Cooling (normal) + Cooling (full speed) =
x A – 1.7A + 4.5A =
x A + 2.8A

Input current from a DC source other than 48 V (based on maximum configuration):

54 VDC input x input current X = 48 VDC x input current Y
54 x X = 48 x 53
X = 48 x 53/54 =
47.1 A

Calculating thermal output (based on maximum configuration):

Watts DC/0.293 = BTU/hr
48 x 53/0.293 =
8682 BTU/hr

System Grounding Guidelines

To meet safety and electromagnetic interference (EMI) requirements and to ensure proper operation, the router must be adequately grounded before power is connected. Two pairs of threaded inserts (PEM nuts) are provided on the right rear of the chassis for connecting the router to earth ground. You use one pair or the other depending on the type of grounding connector (European or American) you use.

To properly ground the router, you need a 6 AWG (13.3 mm^2), 90°C (194°F) grounding cable that is long enough to connect from one pair of grounding points to earth ground, a grounding lug with two holes that fit over the grounding points, and two bolts to attach the lug to the grounding points. The left pair is sized for M6 bolts, and the right pair is sized for UNC 1/4-20 bolts. The grounding cable must be able to handle up to 75 A.

For specifications for the grounding cables, see “Power and Grounding Cable Specifications” on page 51.

For a description of connecting the router to earth ground, see “Connect Power to the Router” on page 134.

Network Cable Requirements

Table 20 lists the specifications for each type of network cable used by the router. You must supply all the cables listed except those indicated as shipping with the router.

Table 20: Network Cable Specifications

Cable Type	Cable Specification	Supplied	Maximum Length	Connector Specification
Single-mode interface (fiber)	SC-SC duplex	No	Short reach: 1.25 mi (2 km)	SC
	LC (for 4-port OC-48/STM-16 PIC)	No	Short reach: 1.25 mi (2 km)	LC
Multimode interface (fiber)	SC-SC duplex	No	Intermediate reach: 9.3 mi (15 km)	SC
Routing Engine console and auxiliary ports	RS-232 serial	One 6-foot length with DB-9/DB-9 connectors	6 ft (1.83 m)	DB-9 male
Routing Engine Ethernet port	Category 5 or equivalent, suitable for 100BaseT operation	One 15-foot length with RJ-45/RJ-45 connectors	328 ft (100 m)	RJ-45

Site Wiring Guidelines

You should consider the following factors when planning the wiring and cabling at your site:

Distance Limitations for Signaling on page 54

Radio Frequency Interference on page 54

Electromagnetic Interference on page 55

Distance Limitations for Signaling

If wires are installed improperly, they can emit radio interference. In addition, potential damage from lightning strikes increases if wires exceed recommended distances, or if wires pass between buildings. The electromagnetic pulse (EMP) caused by lightning can damage unshielded conductors and destroy electronic devices. If your site has previously experienced such problems, you might want to consult experts in electrical surge suppression and shielding.

Radio Frequency Interference

If in your site wiring you use twisted-pair cable with a good distribution of grounding conductors, the site wiring is unlikely to emit radio frequency interference (RFI). If you exceed the recommended distances, use a high-quality twisted-pair cable with one ground conductor for each data signal when applicable.

Electromagnetic Interference

If your site is susceptible to strong electromagnetic interference (EMI), particularly from lightning or radio transmitters, you might want to seek expert advice. Strong EMI could destroy the signal drivers and receivers in the router and could conduct power surges over the lines into the equipment, resulting in an electrical hazard.

It is particularly important to provide a properly grounded and shielded environment and to use electrical surge suppression devices.

Fiber-Optic Connection Guidelines

This section discusses the following topics related to connecting fiber-optic interfaces:

Connector Cleaning on page 55

Multimode Fiber on page 55

Single-Mode Fiber on page 56

Attenuation and Dispersion on page 56

Calculate the Power Budget and Power Margin on page 57

Interoperability for SONET/SDH OC-48/STM-16 PIC on page 59

Interoperability for SONET/SDH OC-192/STM-64 PIC on page 59

End-to-end and Loopback Connections for SONET/SDH OC-192/STM-64 PIC on page 60

Connector Cleaning

Keep fiber-optic cable connectors clean using an appropriate fiber-cleaning device, such as RIFOCS 945/946 Fiber Optic Connector Cleaning System. For more information about cleaning the connectors, see “Fiber-Optic Connector Cleaning” on page 229.

Multimode Fiber

Multimode fiber is large enough in diameter to allow rays of light to internally reflect or bounce off the inner walls of the fiber. Light sources on interfaces with multimode optics are typically LEDs, which are not coherent light sources. An LED sprays varying wavelengths of light into multimode fiber, which reflects the light at different angles. Light rays travel in jagged lines through a multimode fiber, causing signal dispersion. When light traveling in the fiber core radiates into the fiber cladding, higher-order mode loss (HOL) results. All these factors limit the transmission distance of multimode fiber compared to single-mode fiber.

Multimode fiber has an approximate maximum transmission distance of up to 1.5 mi (2 km). Significant signal loss, causing unreliable transmission, can occur at greater distances.

Single-Mode Fiber

Single-mode fiber is so small in diameter that there is not enough room for the rays of light passing through it to reflect internally through more than one layer. Light sources on interfaces with single-mode optics are lasers, which generate rays of light in a single wavelength and which travel in a straight line, directly through the single-mode fiber. Single-mode transmission is useful for longer distances and is capable of higher bandwidth than multimode fiber. However, it is also more expensive.

The maximum distance between transponders is determined by fiber loss, chromatic dispersion, transmitter power, and receiver sensitivity. Table 24 on page 58 lists the factors that contribute to link loss.

The router uses optical lasers for SONET/SDH PIC OC-12/STM-3, OC-48/STM-16, and OC-192/STM-64 single-mode interfaces. These optics are compliant with IR-1 of Bellcore GR-253-CORE Issue 2, December 1995 and ANSI TI.105.06. OC-192 optics are compliant with the Telecordia GR-1377 standard.

Table 21 lists the wavelength range supported by single-mode and multimode PIC interfaces.

Table 21: Wavelength Ranges Supported by Fiber-Optic Cable Types

Fiber-Optic Cable Type	Wavelength Range Supported
SONET / SDH	
SONET/SDH OC-12/STM-4 MMF	1270–1380 nm
SONET/SDH OC-12/STM-4 SMF-IR	1274–1356 nm
SONET/SDH OC-48/STM-16 SMF-LR	1500–1580 nm
SONET/SDH OC-48/STM-16 SMF-SR	1266–1360 nm
SONET/SDH OC-192/STM-64 SMF-LR	1530–1565 nm
SONET/SDH OC-192/STM-64 SMF-SR-2	1530–1565 nm
SONET/SDH OC-192/STM-64 MMF-VSR	830–860 nm

Attenuation and Dispersion

A functional optical data link depends on modulated light reaching the receiver with enough power to be correctly demodulated. Attenuation is the reduction in power of the light signal as it is transmitted. Attenuation is caused by passive media components, such as cables, cable splices, and connectors. While attenuation is significantly lower for optical fiber than for other media, it still occurs in both multimode and single-mode transmission. An efficient optical data link must have enough light available to overcome attenuation.

Dispersion is the spreading of the signal in time. The following two types of dispersion can affect an optical data link:

Chromatic dispersion—The spreading of the signal in time resulting from the different speeds of light rays.

Modal dispersion—The spreading of the signal in time resulting from the different propagation modes in the fiber.

For multimode transmission, modal dispersion, rather than chromatic dispersion or attenuation, usually limits the maximum bit rate and link length. For single-mode transmission, modal dispersion is not a factor. However, at higher bit rates and over longer distances, chromatic dispersion, rather than modal dispersion, limits maximum link length.

An efficient optical data link must have enough light to exceed the minimum power that the receiver requires to operate within its specifications. In addition, the total dispersion must be less than the limits specified in Telecordia GR-253-CORE Section 4.3 and ITU G.957 for the type of link.

When chromatic dispersion is at the maximum allowed, its effect can be considered as a power penalty in the power budget. The optical power budget must allow for the sum of component attenuation, power penalties (including those from dispersion), and a safety margin for unexpected losses. For more information calculating the power budget, see “Calculate the Power Budget and Power Margin” on page 57.

Calculate the Power Budget and Power Margin

The power budget (P_B) is the maximum possible amount of power that can be transmitted over the link. When you calculate the power budget, you use a worst-case analysis to provide a margin of error, although all the parts of an actual system do not operate at the worst-case levels. To calculate the worst-case estimate of power budget (P_B), you assume minimum transmitter power (P_T) and minimum receiver sensitivity (P_R).

Table 22 lists the power specifications for SONET/SDH PICs. Table 23 lists equations for calculating the power budget for SONET/SDH PIC interfaces.

Table 22: FPC3 SONET / SDH PIC Power Specifications

Interface	Max. input (dBm)	Min. input (dBm)	Max. output (dBm)	Min. output (dBm)
OC-192/STM-64 SR-2	–1	–15	0	–4
4-port OC-48/STM-16 SR	0	–18	–3	–11

Table 23: Power Budget Calculation for SONET / SDH PIC Interfaces

PIC Interface	Power Budget Equation
Multimode	P_B = PT – PR P_B = –15 dBm – (–28 dBm) P_B = 13 dB
OC-12 single-mode	P_B = PT – PR P_B = –15 dBm – (–28 dBm) P_B = 13 dB
OC-48 single-mode	P_B = PT – PR P_B = –5 dBm – (–18 dBm) P_B = 13 dB

After you have calculated the power budget, you can calculate the power margin (P_M), which estimates the amount of power available for the link after subtracting attenuation or link loss (LL) from the power budget. A worst-case estimate of P_M assumes maximum LL:

$$P_M = P_B - LL$$

A P_M greater than zero indicates that the power budget is sufficient to operate the receiver.

Table 24 lists the factors that contribute to link loss and estimates the link-loss value attributable to those factors.

Table 24: Link Loss Estimation

Link-Loss Factor	Estimate of Link-Loss Value
Higher-order mode losses	Single-mode—None Multimode—0.5 dB
Modal and chromatic dispersion	Single-mode—None Multimode—Product of bandwidth and distance must be less than 500 MHz/–km
Connector	0.5 dB
Splice	0.5 dB
Fiber attenuation	Single-mode—0.275 dB/km (OC-192/STM-64); 045dB/km (OC-48/STM-16) Multimode—1 dB/km

Power Margin Examples

The following example calculates a multimode power margin using the following variables:

Length of multimode link—2 km

Number of connectors—5

Number of splices—2

Higher-order loss

Clock recovery module

Calculate the power margin as follows:

PM = PB – LL
PM = 13 dB – 2 km (1.0 dB/km) – 5 (0.5 dB) – 2 (0.5 dB) – 0.5 dB (HOL) – 1 dB (CRM)
PM = 13 dB – 2 dB – 2.5 dB – 1 dB – 0.5 dB – 1 dB
PM = 6 dB

The following example calculates the single-mode fiber power budget for two sites that are 8 km apart, connected with single-mode SONET cable with seven connectors.

Length of single-mode link—8 km

Number of connectors—7

Calculate the power margin as follows:

PM = PB – LL
PM = 13 dB – 8 km (0.5 dB/km) – 7 (0.5 dB)
PM = 13 dB – 4 dB – 3.5 dB
PM = 5.5 dB

The calculated value of 5.5 dB indicates that this link has sufficient power for transmission and does not exceed the maximum receiver input power.

Interoperability for SONET/SDH OC-48/STM-16 PIC

The SONET/SDH OC-48/STM-16 PIC is a short-reach (SR) interface, unlike the OC-48/STM-16 interface used in M40 and M20 routers, which is an intermediate-reach (IR-1) interface. These two interfaces have different input and output power levels, as shown in Table 22.

The IR-1 interface may transmit more power than the SR-1 PIC can receive without experiencing saturation. To prevent saturation from occurring, you might need to attenuate power at the SR-1 receiver. The IR-1 receiver should not require attenuation, because the SR-1 transmit levels do not exceed the IR-1 receive levels.

To determine the amount of attenuation needed, measure the power level at each receiver. Attenuate the power to bring it within the allowable range; for short lengths of fiber, with fiber and connector loss close to zero, an attenuator of 5-10 dB should be sufficient.

Interoperability for SONET/SDH OC-192/STM-64 PIC

The SONET/SDH OC-192/STM-64 interface is an SR-2 interface, with a transmit wavelength of 1550 nm. Some OC-192/STM-64 interfaces from other vendors are SR-1 interfaces, which have a transmit wavelength of 1310 nm. The OC-192/STM-64 SR-2 interface can receive at both 1310 nm and 1550 nm.

To ensure interoperability with other vendors' SR-1 and SR-2 interfaces, follow these guidelines:

Be sure the power levels of the send and receive interfaces are matched by checking that the actual power at the receiver is within the range of acceptable power levels.

When connecting SR-2 and SR-1 interfaces, allow an extra 1 dB of margin in the power budget to account for minor variations in receiver sensitivity at different wavelengths.

End-to-end and Loopback Connections for SONET/SDH OC-192/STM-64 PIC

The receiver of a SONET/SDH OC-192/STM-64 PIC has very high sensitivity and low minimum and maximum allowable power. When connecting two SONET/SDH OC-192/STM-64 interfaces, follow these guidelines:

Determine the minimum and maximum for both the transmit power and the allowable receive power.

Measure the transmitted power at the receiver to account for all connector and fiber cable losses.

Add attenuation before the receiver to bring the power levels within allowable range.

> **Caution**
>
> Because the SONET/SDH OC-192/STM-64 SR-2 PIC transmits at a maximum output power of 0 dBm, it could saturate the OC-192/STM-64 SR-2 receiver, which has a minimum sensitivity of –1 dBm. When connecting two SONET/SDH OC-192/STM-64 interfaces with a fiber that has less than 1 dB of loss (shorter than 5 km), a 5 dB attenuator before the receiver should be sufficient to bring the receiver within the allowable range.

Site Preparation Checklist

To help prepare your site for installing the router, use the checklist in Table 25.

Table 25: Site Preparation Checklist

Item or Task	Prepared By	Date	Notes
Assess temperature, humidity, altitude, and other environmental requirements.			
Locate power sources, and measure the distance to system installation site.			
Select the type of rack to be used.			
Measure space for the rack, including specified maintenance clearances.			
Acquire specified cables and connectors.			
Locate sites for connection of system grounding.			
Secure rack to the floor and building structure.			
Assess the power budget and power margin for your site.			